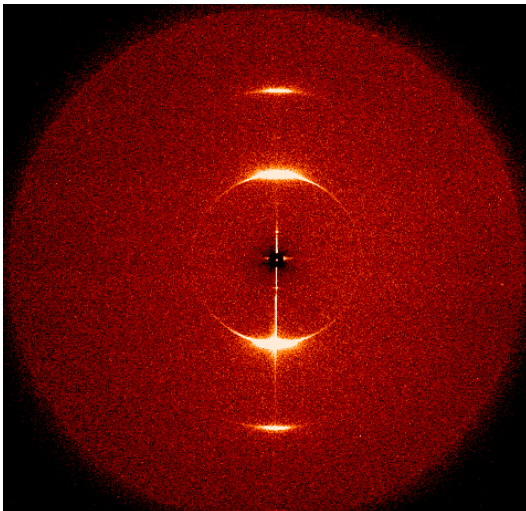
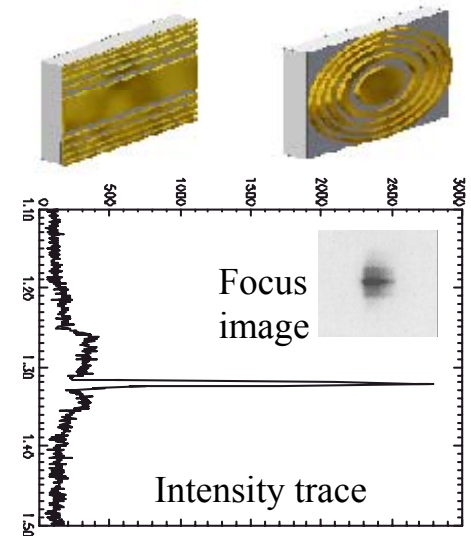


Development of a Short Wavelength X-ray Microscope

Cyrus R. Safinya, Evelyn Hu, Youli Li, UC Santa Barbara, DMR-0076357

Recent Activities

New Focusing Optics for Short Wavelength X-rays Innovations leading to new focusing optics is key in developing a short-wavelength x-ray microscope. We developed a new type of Bragg-Fresnel lens suitable for studies (described below) requiring high energies (> 40 keV). The Fresnel lenses are written by electron beam lithography and formed by depositing a thin Au layer (~ 2000 Å) on x-ray reflective substrates (e.g. Si). **Figure to the right: (TOP) illustration of linear and elliptical metal-layer Bragg-Fresnel lenses (ML-BFLs); (BOTTOM) focusing data collected from a linear ML-BFL at the Advanced Photon Source. The focused beam is of order $1\text{ }\mu\text{m}$.** (Li, Wong, Case, Safinya, Caine, Hu, Fernandez, *Appl. Phys. Letts.* **77**:313-315, 2000)



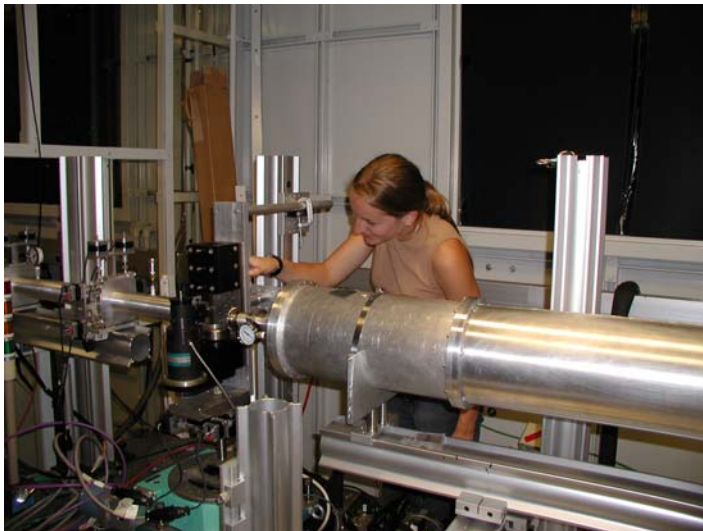
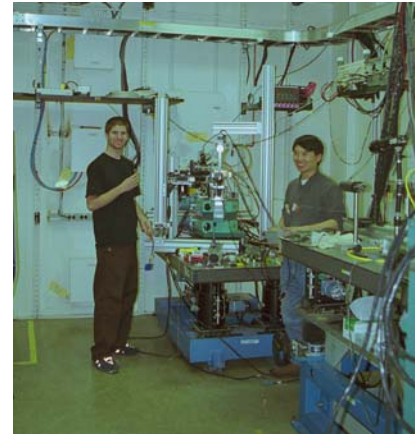
Microimaging: Short wavelength x-ray microscopes have enormous potential in imaging of both soft and hard materials. Applications include mapping out the spatial distribution of heavy metal toxins in environmental soils, or the precise location of zinc-finger proteins (molecular switches that turn genes on) in cells during cell division. **Microdiffraction:** **Figure to the left shows an x-ray microdiffraction pattern from a highly aligned DNA-membrane sample confined between glass plates separated by $100\text{ }\mu\text{m}$. A $1\text{ }\mu\text{m}$ size beam (produced by the metal-layer BFL described above) allowed us to map out the spatial distribution of the membrane-orientation on the several micron scale.** (Li, Golan, Israellachivili, Safinya, et. al, *Int. J. Thermophys.* **22**: 1175, 2001)

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Education, Outreach and Mentoring

Research and development are conducted by postdoctoral researchers, graduate and undergraduate students with active mentoring by the PI's. For most undergraduate students, this is their first experience in a research environment and many are inspired to go on to graduate school to continue their research. Photo to the right shows undergraduate student Mario Yasa with Co-PI Dr. Youli Li at the Advanced Photon Source during an experiment to characterize x-ray optics. Mario will start in the physics graduate program at UCSB in fall of 2002.



Students are strongly encouraged to take a hands on approach and contribute to developing cutting edge instrumentation to enhance capabilities of the lab, which is integrated with the central x-ray diffraction facility of the UCSB Materials Research Laboratory (MRL). The group actively participates in outreach activities run by the MRL and hosts several interns every summer. In photo to the left, graduate student Jayna Jones is using a state-of-the-art small angle x-ray scattering instrument that the students help build to study soft condensed matter and biological materials. Jayna studies neurofilaments (derived from nerve-cells) to learn about their self-organized structures in-vitro, on the 10nm to 100nm length scale, and their role in stabilizing nerve cells.